Modal-temporal interactions

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This chapter concentrates on the interaction between modal verbs and tense-aspect operators. It explores the question of the link between types of modality and temporal configurations by adopting a precise framework for the analysis of temporal configurations in modal environments and by tracing the development of the hypothesis of a structural difference between epistemic and non-epistemic modals.

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1. Introduction

Formal research on tense and aspect, on the one hand, and modality, on the other, has only started to converge over the past fifteen years. This chapter is devoted to the main domain of this convergence, namely the study of the interaction of modal verbs with tense and aspect operators. For reasons of space, we are not taking into account modal sentential adverbs (*possibly, necessarily*) or adjectival predicates of propositions (*It is possible that p...*). Their interaction with tense is different and has not been systematically investigated (but see Iatridou 1990, Wolf 2014).

Modal-temporal interactions constitute a relatively new and complex area of investigation, where a wide range of structural, lexical, and possibly pragmatic factors come into play. The goal of this chapter is to give an overview of current research and to outline the main issues in need of further research. Through the combined pressure of a wealth of new cross-linguistic data and the general adoption of possible world semantics for the interpretation of modality, the field is gradually moving away from some restrictive syntactic hypotheses concerning the interaction of modal and temporal heads. However, the main tenet underlying these restrictive hypotheses, namely that different types of modality interact differently with time, seems robust enough. Unfortunately, there is as yet no consensus as to the classification of overarching types of modality (for discussion, see Portner 2009: 132-141, Matthewson 2014), nor, more importantly, on the diagnostics for identifying them. This obviously constitutes a major obstacle for formulating adequate generalizations. We have tried to overcome this difficulty by sticking as much as possible to the traditional split between epistemic and root modalities, which is in its origins a syntactic split with semantic correlates (Hofmann 1966), introducing finer-grained modal distinctions when they appear relevant (See also Chapter 57 *Epistemic Modality* and Chapter 59 *Graded modality*). It is important to bear in mind that, when using "epistemic" as a semantic label, we are restricting it to interpretations of modals which are intrinsically dependent on the information or evidence available to a particular epistemic agent (which in matrix sentences is normally the speaker). This contrasts with "objective" modalities, which deal with the way things are. For "objective" modalities, we will make no principled difference between the terms "metaphysical" and "circumstantial". For the purposes of our discussion, this difference can be safely ignored, since we assume that both build on the same temporal structure contrasting a fixed past and present with an open future (see below, section 1.1).

The formal treatment of the temporal dimension is rather uniform, insofar as (i) the threefold distinction between temporal location as expressed by tense, (time-relational or viewpoint) aspect as a function mapping predicates of eventualities onto predicates of times, and aspectual classes of predicates of eventualities is practically universally adopted, and (ii) time is modelled as a linear order of instants (at least for times up to the moment of evaluation, see below section 1.1). By contrast, in the treatment of the modal dimension there are several competing approaches (for an overview, see Portner 2009). In this chapter, we adopt the Kratzerian approach to modality, according to which modal expressions are quantifiers over possible worlds, and their quantification domain is contextually restricted by a double modal background constituted by two functions from worlds into sets of propositions, the **modal base** and the **ordering source**. The reader should bear in mind that modal bases *qua* functions from worlds into sets of propositions are translatable into binary relations between worlds (the accessibility relations which are more widely used in the semantic interpretation of modal logic systems) and viceversa. The reason is that the denotation of a set of propositions can be defined as the set of worlds verifying every proposition in the set (see Kaufmann, Condoravdi & Harizanov 2006, Portner 2009: Chap. 3),[1] and a function from worlds into sets of worlds can be expressed as a binary relation between worlds. In the remainder of this chapter, we will treat modal bases as functions from worlds into sets of worlds. We will have little to say about ordering sources, since their relation with time has rarely -if at all- been discussed in the literature. Nonetheless, it seems evident that if modal bases change with time - because the course of events inevitably reduces what is factually or epistemically possible -, this is even more clearly the case for the social norms or for the preferences embodied in ordering sources. Thus, for instance, (1a) and (1b) allude to changes in school regulations which determine time-related differences in the relevant ordering source:

(1) a. From next Monday on, Mary will have to wear a uniform at school.
b. Until the beginning of the 90s, students could smoke in class.

In the remainder of this section, we present a semantic approach that identifies the necessary ingredients for describing temporal configurations in modal environments and assigns different formal structures to epistemic and non-epistemic modal bases (1.1), while at the same time attempting to capture the way in which the aspectual makeup of the complement of a modal affects the temporal configuration (1.2). Section 2 traces the evolution of structural accounts of the epistemic-root distinction - which attribute the differences in interaction with time to a more general pattern of scopal contrasts - and takes up the issue of epistemic modals bearing past morphology. Section 3 discusses two issues pertaining to the interaction of modals with tense and aspect categories which have attracted wide attention in recent years, namely the epistemic-counterfactual ambiguity and the actuality entailment.

1.1 Temporal configurations and types of modality

In order to describe temporal configurations in modal environments, it is necessary to distinguish at least two times whose relative location directly affects the interpretation of a modal statement: the time of the eventuality described and the time of modal evaluation, the latter constituting the time from which the modal background (i.e. the modal base and ordering source restricting the domain of worlds being quantified over) is accessed. The notions of temporal orientation and temporal perspective introduced by Condoravdi (2002) serve precisely this purpose. According to her proposal, temporal perspective is the relationship between the time of modal evaluation and the time of utterance. By contrast, temporal orientation is the relationship between the time of the eventuality described and the time of modal evaluation.

For instance, (2a) exhibits a present temporal perspective (TP) and a future temporal orientation (TO), whereas (2b) exhibits a present temporal perspective and a past temporal orientation:

(2) a. The bomb must fall near the bridge. [PRESENT TP, FUTURE TO]
'It is now necessarily the case that the bomb falls near the bridge at some time later than now.'
b. The bomb must have fallen near the bridge. [PRESENT TP, PAST TO]
'It is now necessarily the case that the bomb fell near the bridge at some time before now.'

In this setup, there is no direct relationship between the time of the eventuality and the time of utterance. This relationship is indirectly determined by the present temporal perspective in the examples above, but it may remain undetermined in cases combining a past temporal perspective with a future temporal orientation, as is the case in the following examples:

(3) a. Mary should have taken the train yesterday / tomorrow.
'It was necessarily the case at some time before now that Mary takes the train at some later time included in yesterday/ tomorrow.'
b. *Marie devait prendre le train hier / demain*. [FRENCH]
Marie must.IMPF take the train yesterday / tomorrow.
'It was necessarily the case at some time before now that Mary takes the train at some later time included in yesterday/tomorrow.'

There seems to be a clear correlation between temporal configurations and types of modality, though the exact import of this correlation remains elusive. Its most salient aspect is the link between future temporal orientation and circumstantial or metaphysical modal bases, i.e. those modal bases that involve facts and do not depend primarily on the partial information or evidence available to an epistemic agent. It has repeatedly been observed that epistemic readings of modals tend to be associated with a past or simultaneous temporal orientation, as is the case in (2b), whereas deontic readings (which rely on circumstantial modal bases) mostly involve a future temporal orientation, as illustrated in (2a). Enç (1996) is one of the first analyses attributing to deontic *must* a semantic definition which shifts the time of the eventuality forward from the time of modal evaluation.

Work by Condoravdi (2002), Kaufmann (2005), Kaufmann, Condoravdi & Harizanov (2006) and Werner (2003, 2006) aims at accounting for this correlation by formally distinguishing between at least two types of modal bases, and by formulating a pragmatic felicity condition (the "diversity condition") on the structure of suitable modal backgrounds. Metaphysical (or "objective") modal bases have the structure of the 'branching futures' time graph (See Chapter 40 *Reference to future events: Sea battles*, as well as Steedman 1997, Thomason 1984). For any time of evaluation t, a linear 'fixed' past and present constituted of times that precede or are simultaneous to t is distinguished from an 'open' future of alternatives fanning out after t. Such structures constitute equivalence classes of worlds (conceived of as "world histories") relative to a time t: the members of the equivalence class are indistinguishable up to and including t, but may diverge after t. Formally, a metaphysical modal base relative to a world w and a time t is the set of worlds that agree with w up to time t, but (possibly) diverge afterwards:

(4) $MB_t(w) := \{w' \in W \mid w'$ verifies exactly the same propositions as w up to time t$\}$

As for the diversity condition, a modal base is said to be *diverse with regard to a proposition* ϕ iff it contains both worlds verifying and worlds falsifying ϕ:

(5) $\exists w', w''\ \ w' \in MB \wedge w'' \in MB\ \wedge w' \in \phi \wedge w'' \notin \phi$

Given the formal definition of the modal base in (4), the diversity condition in (5) cannot be fulfilled for propositions whose truth or falsity is established at t: any proposition ϕ whose truth value depends on facts not later than t will be uniformly true ("settled") or uniformly false in the modal base. Thus, in a metaphysical modal base, only future orientation with regard to t may fulfill the diversity condition.

By contrast, epistemic (or doxastic) modal bases are designed to capture the subjective uncertainty or partial information of an epistemic agent.[2] They are thus relativized to a world, a time and an epistemic agent:

(6) $MB_t^{EpAg}(w) :=$ {w' ∈ W | w' verifies exactly the same propositions that are believed/known by EpAg in w at t}

If the relevant epistemic agent is uncertain as to the truth or falsity of a proposition ϕ (if she neither knows/believes ϕ nor $\neg\phi$), the modal base will contain both ϕ worlds and $\neg\phi$-worlds, thus fulfilling the diversity condition for ϕ regardless of temporal orientation.

The difference between the two types of modal base can be illustrated by the following example:

(7) John may have won yesterday's game.

In (7), the temporal perspective is present and the temporal orientation is past. Since the issue of John's winning the game is decided at the time the modal base is accessed, which is the time of utterance in this example, a metaphysical or objective modal base will uniformly contain either only worlds in which he won the game, or only worlds in which he didn't. By contrast, an epistemic modal base modelling the 'ignorance alternatives' of an epistemic agent who does not know which way things went will contain both world histories in which John won and world histories in which he didn't. In such a temporal configuration, only the epistemic modal base fulfills the diversity condition.

The pragmatic requirement that the modal base be diverse[3] is meant to explain the correlation between non-future orientation and the choice of an epistemic modal base for the interpretation: since metaphysical modal bases can only satisfy the diversity condition if the temporal orientation is future, for a non-future temporal orientation, the only option is an epistemic modal base.[4]

According to this formulation, it is temporal orientation that determines - at least partially - the choice of modal base. This is the perspective adopted by Condoravdi (2002) and Kaufmann (2005). It contrasts with Werner's (2003, 2006) approach, in as far as the latter tries to derive the temporal configuration from the type of modality. The former strategy seems more adequate for languages in which most modals have both epistemic and non-epistemic readings. In such languages, the choice of modal base is highly context-dependent,[5] whereas temporal configurations can in principle be compositionally calculated from explicit material in the sentence (at least in languages with rich tense-aspect morphology). As we will see in the following sections, however, calculating temporal configurations in sentences containing modal verbs is no straightforward matter. The difficulties pertaining to this task are actually predicted by the distinction between temporal perspective and temporal orientation: such temporal configurations require two relations to be specified, but more often than not

morphology overtly specifies only one of them, the other one being determined either by covert operators or calculated by default.

1.2 Temporal orientation, aspectual classes and aspect

Aspectual properties are one of the main factors affecting temporal configurations in modal environments. A recurrent observation in the literature is that - in the absence of overt aspectual operators - the aspectual class (See Chapter 37 *Lexical aspect*) of the described eventuality has an influence on temporal orientation (Stowell 2004, Condoravdi 2002 among many others). States have a default simultaneous ('present') temporal orientation (though they may acquire a future temporal orientation in the presence of explicit or implicit temporal adverbials). In English, this contrasts with the uniform future temporal orientation of eventive predicates (unless they receive a habitual interpretation, and thus function as derived statives).

(8) a. Peter might be ill. [STATE - SIMULTANEOUS TO]
b. Peter might get ill. [EVENT - FUTURE TO]
c. Peter might sing or dance. [EPISODIC - FUTURE TO; HABITUAL - SIMULTANEOUS TO]

In other languages, such as Spanish, future temporal orientation is only uniform for *bona fide* telic predicates, whereas atelic predicates allow for simultaneous or future temporal orientation (Laca 2012).[6]

(9) a. *Pedro puede estar enfermo*. [SPANISH]
Peter can.PRES be ill
'Peter might be ill. ' [STATE - SIMULTANEOUS TO]
b. *Pedro se puede enfermar*. [SPANISH]
Peter REFL can.PRES get ill
'Peter might get ill.' [TELIC - FUTURE TO]
c. *Puede llover*. [SPANISH]
can.PRES rain
'It might rain. / It might be raining.' [ATELIC - FUTURE TO OR SIMULTANEOUS TO]

Condoravdi (2002) captures the correlation between temporal orientation and the stative-eventive contrast by assuming that instantiations of an event at an interval have to be temporally included in this interval, whereas instantiations of a state at an interval only require temporal overlap. She further assumes that modals uniformly introduce a Modal Time at which the existence of the described eventuality is to be evaluated. Modal Time is an interval whose left boundary coincides with the time from which the modal base is accessed, and which stretches indefinitely into the future.

Condoravdi's conception of Modal Time corresponds to Abusch's (2004) semantic definition of the operator *will* (which is itself a "rightward-oriented" version of the "extended now" used in some analyses of the perfect). Since eventives have to be included in this interval, they will start no earlier than the left boundary of Modal Time and will thus be forward-shifted with regard to this boundary. By contrast, states may start before the left boundary of Modal Time, giving rise to simultaneous temporal orientation.

The introduction of Modal Time as an interval without a right boundary has had important consequences for some syntactic analyses of the interaction between modals and tense/aspect operators (see below, Demirdache & Uribe-Etxebarria 2006 *et seq*). It seems nonetheless clear that the crucial anchor for temporal orientation is the left boundary of Modal Time, which is a point in time. The question thus arises whether the ultimate explanation for the contrast in

temporal orientation between statives and eventives is not simply that states may be evaluated at a point in time, whereas events are necessarily evaluated at intervals (see Dowty 1979 among many others).

By contrast with most existing analyses, which attribute future temporal orientation to the semantic contribution of the modals themselves, modulo their interactions with the aspectual makeup of the eventuality description they embed, Matthewson (2011) has recently developed an account in which the insertion of prospective viewpoint aspect (which places the temporal trace of the event after the reference time) below the modal is responsible for future temporal orientation. Prospective operators may be overt and obligatory, as is the case in Gitksan (Tsimshianic, British Columbia), which, interestingly enough, requires it for all circumstantial modals. Thus, for instance, the non-epistemic possibility modal *da'akhlxw* in (10) selects for the prospective marker *dim*, which, as shown in (11a-b), must overtly mark future orientation:

(10) *Context: You are talking about some land you used to have. I ask you 'What was the soil like? Could berries have grown there?'*
***da'akhlxw**-i=hl maa'y=hl dim limxs-t* [GITKSAN]
CIRC.POSS-TRA=CN berries=CN PROSP grow.PL-3SG.II
'Berries could have grown.'

(11) a. *siipxw=t James (k'yoots)* [GITKSAN]
sick=DM James (yesterday)
'James was sick (yesterday)./ James is sick.'
b. ***(dim)** siipxw=t James t'aahlakw*
*(FUT) sick= DM James tomorrow
'James will be sick tomorrow.'

These facts shed doubt on the cross-linguistic adequacy of attributing future orientation to the properties of Modal Time and its interaction with eventives. Instead of assuming that the properties of Modal Time may vary cross-linguistically, it seems preferable to assume that Modal Time is simply the point in time from which the modal base is accessed, and that languages differ mainly in their aspectual and temporal makeup, particularly regarding which aspects may be covert. In English, progressive aspect must be overtly expressed, so that bare eventive predicates will be interpreted non-progressively. In Spanish, progressive aspect must be overtly expressed with *bona fide* telic predicates, but it may be covert with activities.

Now, since non-progressive eventive predicates cannot be evaluated at a point in time, they will be shifted. And they can only be shifted towards the future, because anteriority, again, has to be overtly marked in such languages (namely, by perfect morphology on non-finite forms or by past tense in finite forms).[7] By contrast, Gitksan is a FUTURE-NON FUTURE language in which prospective aspect/future tense cannot be covert. Such a language so to say wears the future orientation of circumstantial modals on its sleeve, because of the obligatory co-occurrence of circumstantial modals with the prospective marker *dim*. Notice that the differences between English and Spanish, on the one hand, and Gitksan, on the other, do not affect the generalization according to which circumstantial modals have a future temporal orientation, nor the motivation of this generalization by the diversity condition on modal bases. They simply show that the conditions under which future temporal orientation arises vary according to the tense-aspect makeup of the language.

2. The role of scope in the interaction between modals and tense

2.1 Epistemic and root modals have different scope properties

The interaction between modal and temporal operators has long been thought to be determined by the scope properties of the modals. A large number of studies on modals assume a distinction between epistemic and root interpretations, the traditional claim being that epistemic modals scope high (IP-level) and root modals scope low (VP-level) (Ross 1969, Perlmutter 1970, Jackendoff 1972, Huddleston 1974, Zubizarreta 1982, Iatridou 1990, Picallo 1990, Brennan 1993, Cinque 1999, Butler 2003, Hacquard 2006, a.o.).[8] Before discussing the issues raised by the assumption of a sharp scope split between epistemic and root modals, as well as its subsequent refinements, let us briefly review some of the evidence that has been initially adduced in favor of this claim.

First, when a root and an epistemic modal co-occur, the root modal cannot take scope over the epistemic modal. The following Catalan examples, due to Picallo (1990), illustrate this:

(12) *En Pere deu poder tocar el piano*. [CATALAN]
the Pere must can play the piano
i. 'It must be the case that Pere is able/allowed to play the piano.'
ii. '*It must be the case that it is possible that Pere would play the piano.'

(13) *En Jordi pot haver de venir*. [CATALAN]
The Jordi may have to come
i. 'It is possible that Jordi is obliged/compelled to come.'
ii. '*It is permitted that it is necessarily the case that Jordi comes.'

The reverse order is not attested with modal auxiliaries, suggesting that the epistemic modal takes higher scope.

Further evidence in favor of the claim that epistemic and root modals are interpreted at different levels of the structure has come from their interaction with other operators, such as quantified subjects (Brennan 1993, Butler 2002) or negation (Drubig 2001). As an illustration, consider the sentence in (14), where the modal auxiliary is ambiguous between an epistemic and a deontic interpretation. Crucially however, on the epistemic reading, the modal scopes higher than negation, while on the deontic reading, the modal is interpreted in the scope of negation:

(14) Mary may not move to London.
i. It is possible that Mary does not move to London. $\text{MODAL}_{\text{EPISTEMIC}} > \text{NEG}$
ii. *It is not the case that it's possible that Mary moves to London.
iii. Mary is not allowed to move to London. $\text{NEG} > \text{MODAL}_{\text{ROOT}}$
iv. *Mary is allowed not to move to London.

Drubig (2001) shows that similar conclusions hold for other languages, such as Malay: if the modal is interpreted as epistemic, it must precede negation (15a-b), unlike in the case of root modals, where negation comes first (16):

(15) a. *Dia boleh jadi tidak suka saya* [MALAY]
he may not like me
b. **Tidak boleh jadi dia suka saya*
not may he like me
'He $\text{may}_{\text{EPIST}}$ not like me.'

(16) *Dia tidak boleh belajar* [MALAY]
he not may study

'He is not allowed/able to study.'

Epistemic and root modals have also been argued to interact differently with (grammatical) aspect (e.g. Bhatt 1999, Hacquard 2006, 2009). To illustrate, let us consider the interaction with perfective aspect (which will be discussed in detail in section 3). Hacquard (2009) argues that root modals in combination with a perfective form give rise to the entailment that the event described in the VP took place in the actual world. The existence of this entailment (the 'actuality entailment') is confirmed by the contradiction arising in the following French examples, with an ability modal (17a) and a deontic modal (17b):[9]

(17) a. *Jane a pu prendre le train pour aller à Londres, #mais elle* [FRENCH]
Jane has can.PART take the train to go to London but she
a pris l'avion.
has taken the plane
'Jane was able to take the train to go to London, but she took he plane.'

b. *Lydia a pu aller chez sa tante (selon les ordres de son père),* [FRENCH]
Lydia has can.PART go to her aunt (according orders of her father)
 # mais n'y est pas allée.
but there is not gone
'Lydia could go to her aunt (according to her father's orders), but she didn't go.'

No such contradiction arises with epistemic modals, suggesting that the complement is not asserted to hold in the actual world:

(18) *Bingley a (bien) pu aimer Jane, comme il a (bien) pu* [FRENCH]
Bingley has well can.PART love Jane like he has well can.PART
ne pas l'aimer.
not her love
'Bingley may (well) have loved Jane, just as he may (well) not have loved her. '

On the assumption that actuality entailments arise when perfective aspect scopes above the modal (Hacquard 2006), the contrast between (17) and (18) once again can be taken to indicate that epistemic modals take high scope, whereas root modals scope below the aspectual phrase. Accordingly, the two possible interpretations of the sentence in (19a-b) would follow from the possibility to have two different syntactic representations, as schematized below:

(19) a. *Mary put prendre le train*. $\text{MODAL}_{\text{EPIST}}$>ASPECT
'Mary may have taken the train.'
a'.[$_{\text{ModP}}$ can [$_{\text{TP}}$ past [$_{\text{AspP}}$ perf$_1$ [$_{\text{VP}}$ Mary take the train e_1]]]]
a''. There is a world *w* compatible with what is known in the actual world, such that there is a past event in *w* which is a train taking event by Mary.

b. *Mary put prendre le train*. ASPECT>$\text{MODAL}_{\text{ROOT}}$
b'. [$_{\text{TP}}$ past [$_{\text{AspP}}$ perf$_1$ [$_{\text{ModP}}$ can [$_{\text{VP}}$ Mary take the train e_1]]]]
b''. There is a past event e_1 in the *actual world*, which in some world compatible with the circumstances in the actual world is a train taking event by Mary.

Finally, the interaction with tense has also been taken to indicate scopal differences between root and epistemic modality. More precisely, the time of evaluation of a root modal is

generally provided by tense, as illustrated by the sentence in (20), which refers to a necessity holding in the past:

(20) John had to move to London. PAST > $\text{MODAL}_{\text{ROOT}}$
i. Given the circumstances holding at a certain time in the past, it was necessary that John move to London.
ii. *Given the circumstances holding now, it was necessary that John moved to London then.

In contrast to this, the time of modal evaluation of epistemic modals has been argued not to be 'shiftable' by tense (Groenendijk & Stokhof 1975, Iatridou 1990, Abusch 1997, Stowell 2004). In matrix contexts, the time of evaluation is always the utterance time (21), while in embedded contexts, it is the internal 'now' of the attitude holder (22):

(21) The gun had to be hidden in the house. $\text{MODAL}_{\text{EPISTEMIC}}$ > PAST
i. Given what we know *now*, it is necessary that the gun was hidden in the house *then*.
ii. * Given what we knew *then*, it was necessary that the gun was hidden in the house *then*.

(22) The police thought that the gun had to be hidden in the house.
i. It was necessary for the police *at their thinking time* that the gun was hidden in the house at some time in the past.
ii. *It is necessary for the police *now* that the gun was hidden in the house at some time in the past.

These facts have been captured by assuming that epistemic modals cannot be in the scope of tense, thus ensuring no effect of tense operators on the time of modal evaluation. Root modals, on the other hand, seem to take scope below tense, explaining why their modal time is sensitive to the tense operators present in the structure.

Taken together, the facts reviewed above seem to provide converging cross-linguistic evidence that epistemic and root modals have different scope properties. However, despite this type of evidence, it quickly emerged that the scope properties of epistemic and root modals are not as sharp as initially thought.

First, clear counterexamples have emerged, for most interactions discussed above. For example, it has been shown that the interaction between negation and modals is affected by several other factors, such as constraints on the position of negation, the possibility/necessity distinction, as well as idiosyncratic properties of various modal auxiliaries (see Cormack & Smith 2002, von Fintel & Gillies 2007, Iatridou & Zeijlstra 2013 among others). In English for instance, we find epistemic modals that easily scope under negation (23a), and deontic modals that take wide scope with respect to negation (23b):

(23) a. Mary can't be in her office. NEG > $\text{MODAL}_{\text{EPISTEMIC}}$
b. Mary must not arrive late. $\text{MODAL}_{\text{DEONTIC}}$ > NEG

In section 2.3, we will focus on the scope relation that has received most attention and that is most relevant for the present chapter, namely the interaction between modals and tense. We refer to it for detailed discussion of counterexamples to the claim that epistemic modals obligatorily outscope tense.

In addition to such counterexamples, the initial twofold distinction between epistemic and root modals has been called into question by finer-grained classifications. For example, in section 3, we will see that the landscape of non-root modality is not limited to epistemic modals.

A more general concern with the claim that epistemic modals take high, IP-level scope, whereas root modals take low, VP-level scope concerns the very notion of scope that applies, i.e. whether we are dealing with syntactic or semantic scope. We will see below that the explanation for the above-mentioned interactions with tense or aspect is different depending on the notion of scope that is assumed to be relevant, i.e. whether this has to do with the position in which modals are merged or where they are interpreted.

Both cross-linguistic data and subsequent theoretical developments contributed to refining the initial distinction between epistemic and root modality. To understand the changes that led to current approaches to modal–tense interactions, we start by discussing some of the accounts that have been developed to capture the scope differences introduced in this section. This will help explain subsequent refinements of the generalizations concerning the scope of modal operators and the remaining open issues concerning the interaction of modals with tense and aspect.

2.2 Deriving the scope difference

There have been various proposals on how to derive the observed scopal differences. The early generative literature (Ross 1969, Perlmutter 1971, Jackendoff 1972) puts forward lexical accounts of the epistemic/root distinction, with or without a corresponding syntactic distinction. On this line of analysis, epistemic modals are analyzed as one-place predicates, similar to raising verbs, and root modals as two-place predicates, similar to control verbs. While the correlation with the raising/control distinction has been disputed (Picallo 1990, Bhatt 1998, Wurmbrand 1999, Hacquard 2006), it is by now rather widely accepted that there is a structural difference between epistemic and root modals. Picallo (1990) attributes the epistemic/root distinction to different levels of insertion at D-structure: epistemics are merged somewhere within the IP level, and root modals, somewhere within the VP. Brennan (1993) argues that epistemic and root modals occur in different LF positions and select different types of arguments. More specifically, she argues that epistemic modals are merged at IP-level and are proposition-embedding predicates, i.e. they take complements of type <s,t>. On the other hand, root modals are merged at VP-level and combine with properties (of type <e,st>). In other words, the subject of a root modal is assigned a thematic role and is attributed a certain modal property, e.g. an obligation. The different structural positions, which correlate with different embedding properties, explain the scope distinctions and the meaning effects noted in the previous sections.

The hypothesis that the epistemic/root difference is determined syntactically has been strongly advocated by Cinque (1999), who proposes a very richly articulated hierarchy of modal, temporal and aspectual layers. Based on a large cross-linguistic survey of adverbs and functional projections, Cinque argues that the position of modals (and other operators) is determined by a fixed universal hierarchy, with dedicated syntactic projections as represented in (24) (irrelevant projections omitted):

(24) $\text{MODAL}_{\text{EPISTEMIC}} > \text{TENSE} > \text{ASPECT} > \text{MODAL}_{\text{ROOT}}$

Although relying on a large amount of cross-linguistic data, the hierarchy seems to a large extent arbitrary, as it fails to provide the rationale behind the observed scopal differences. Like other proposals that rely on different insertion levels (IP vs. VP), the account faces two major drawbacks. First, it does not capture the fact that in many languages epistemic and root modals tend to be realized by the same lexical expressions; on hierarchies such as (24), the fact that *must* can have both an epistemic and a root interpretation seems an accident, leading to the postulation of massive lexical ambiguity. Second, it does not explain the correlation between

type of modality and structural position: why are epistemics obligatorily high in the clause, while root modals need to occur lower in the structure?

Another important line of thought concerning the scope differences mentioned above consisted in refining the notion of scope. More specifically, several analyses have pointed out (at least apparent) mismatches between syntactic and semantic scope. In particular, analyzing the properties of past tense modal forms, Stowell (2004) argues that the relevant scope relations hold at the interpretive, rather than the syntactic, level. Evidence in favor of this claim comes from sentences such as (25), which contain morphologically past modal forms, but disallow a true past tense interpretation setting the time of modal evaluation in the past. This is most clearly illustrated by the semi-modal in (25), which arguably exhibits a present temporal perspective (the time at which the modal base is accessed coincides with the time of utterance) and a past temporal orientation (the described eventuality is located before the time of modal evaluation), yielding an interpretation akin to 'must have been'. In other words, the past tense in (25) is interpreted as though it were under the scope of the epistemic modal:[10]

(25) There had to be at least a hundred people there.
'There must have been at least a hundred people there.'

Similar considerations apply to the Spanish examples in (26) (due to Bravo 2000), where once again the temporal perspective of the epistemic modal is present (the modal base is accessed from the time of utterance):

(26) *El ladron pudo entrar por la ventana* [SPANISH]
the thief can.IMPF enter through the window
i. 'The thief was able to enter through the window.' (root)
ii. 'It is possible that the thief entered through the window.' (epistemic)

In contrast, as we have already seen in (22) above and further illustrate in (27), when a modal verb bearing past morphology is embedded under a predicate of propositional attitude in the past, the time of modal evaluation can be understood to hold at a past time relative to the actual utterance time (Abusch 1997, Stowell 2004):

(27) a. Caesar knew that his wife might be in Rome.
b. Fred thought that there could be at least a hundred people at the reception.

In order to have a unified generalization covering both embedded and unembedded cases, it has been argued that the interpretation of these epistemic modals is actually a case of simultaneous 'sequence of tense' construal, which is licensed in the same syntactic environments. In other words, past morphology on the modal is in fact an expression of an anaphoric or zero tense, which is interpreted as simultaneous to the time of the embedding attitude verb (see also Chapter 45 *The interpretation of tense*). The generalization that the epistemic modal is construed with a present (simultaneous) temporal perspective thus seems to hold even in embedded contexts.

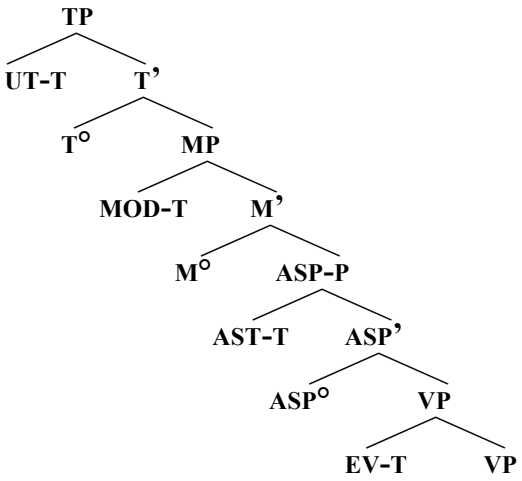
The question then is how to derive the scope reversal between epistemic modals and past tense, observed in (25)/(26). Several mechanisms have been proposed to derive the attested interpretations. One way is to assume a unique insertion position for the modal, on both its root and epistemic interpretations. The scope mismatch displayed by epistemic modals arises via a scope reversal mechanism, whereby the epistemic (semi-)modal is required to undergo movement in the derivation of the Logical Form (LF) representation to a position above that of the past tense. Once the modal is no longer in the scope of past tense, the modal evaluation time

must be understood to coincide with the utterance time. However, since this derivation involves movement of a modal head across a tense head, it has been argued to be at odds with the Head Movement Constraint (Travis 1984).

Stowell (2004) suggests an alternative way to derive the correct time of modal evaluation, which relies on two different base positions for epistemic and root modals (in line with Cinque's hierarchy). On this view, sentences like (25) would be structurally ambiguous in terms of the position of the modal. On the root interpretation, the modal originates in the lower modal position and moves to the head position of the tense phrase to combine with the past tense. On the epistemic interpretation, the modal originates above tense and the tense affix moves to combine with the higher epistemic modal head.

A similar solution is worked out in Demirdache & Uribe-Etxebarria (2006 *et seq*). They develop a detailed syntactic model, which aims to derive the range of possible root/non-root temporal construals, as well as the temporal syntax of the attested readings cross-linguistically, without appealing to dedicated hierarchies of functional projections. More specifically, they uniformly assume the phrase-structure in (23) and argue that the syntactic heads, Tense (T°), Modal (M°), Aspect (ASP°) and V°, each contribute a time argument to the temporal calculus of the clause in which they occur.

(28)



Time arguments are projected into the syntax (in the specifier position of the selecting head) and behave like individual-denoting DPs (following Stowell 1996). In other words, they can enter into anaphoric dependencies and they can undergo (possibly covert) syntactic movement. These assumptions derive a complex array of tense-modal-aspect configurations. For example, in order to account for the apparent scope reversal in the epistemic reading of examples such as (26), they claim that in this case, the anteriority relation conveyed by past morphology originates under T°, but must be lowered into M° in order to avoid a nonsensical temporal configuration in which **UT-T** is ordered after **MOD-T,** which, following Condoravdi (2002) is an interval stretching indefinitely into the future. The proposal has two advantages over reconstruction-based approaches. First, it relies on a single clausal structure, i.e. it does not assume any structural ambiguity. Second, it provides a motivation for movement, which takes place in order to rescue an otherwise illicit temporal configuration.

Summarizing, we have reviewed the main differences between epistemic and root modals and briefly pointed out some ways to capture them. However, the interaction between past morphology and epistemic modality suggests that the picture described in the first two sections (2.1 and 2.2) is more complex than initially assumed. As suggested above and discussed in detail below, this becomes even clearer once embedding takes place or once aspectual

distinctions come into play. In the next section, we will delve into these complexities and discuss their impact on the theories of modal-tense interactions.

2.3 Past morphology and epistemic modals

2.3.1 Past attitudes and past temporal perspective

The dominant tradition in the study of modal verbs assumes either (a) that epistemic modals structurally appear above tense and aspect (Hacquard 2006, 2009) or (b) that they can only appear under the scope of present tense in matrix contexts or of zero tense when embedded under propositional attitudes (Condoravdi 2002, Stowell 2004, Demirdache & Uribe-Etxebarria 2008). Although in both cases the temporal perspective turns out to be simultaneous to the time of a 'content' attitude - the speech act itself or a reported attitude of belief-, the former assumption amounts to a structural, the latter to a semantic hypothesis. According to the latter, the temporal perspective of an epistemic modal must be simultaneous to the time of the attitude, in the same way in which the relevant epistemic agent is identified with the holder of the attitude (see Papafragou 2006). In normal matrix contexts, the time of modal evaluation will be the time of the utterance and the relevant epistemic agent will be the speaker. In the case of modalized sentences embedded under past attitudes, simultaneity with a past attitude will be expressed by tenses which may function as zero tenses in sequence of tense contexts (see also Chapter 47 *Sequence of tense*). Sequence of tense is thus one of the possible sources of past epistemic modals in English, as shown in (29) (see also Stowell 2004).

(29) A year ago, Mary thought that she might/#may be pregnant.

In (29) *may* behaves as a verb bearing a (deictic) present tense, and thus triggers a double access effect which accounts for its unacceptability in this context. *Might,* on the other hand, only requires simultaneity with the time of the reported attitude.

As argued by Boogaart (2007), sequence of tense licenses epistemic modals in the simple past in Dutch, and modals bearing *imparfait* morphology in Romance.

(30) a. *J'ai pensé qu' il pouvait être malade.* [FRENCH]
I have thought that he can.IMPF be ill
'I thought he might be ill.'
b. *Pierre a déduit que l'assassin devait être gaucher.* [FRENCH]
Pierre has inferred that the murderer must.IMPF be left-handed
'Pierre concluded that the murderer must have been left-handed.'

Note that only non-perfective past tenses may be interpreted anaphorically as zero tenses, i.e. expressing simultaneity with a past attitude. It has been noticed that such past tenses appear frequently in free indirect speech or reported thought contexts, where the past attitude (and the attitude holder) have to be inferred from context. Thus, in the following excerpt in Spanish, the past attitude licensing *imparfait* morphology on the modals is that of the parents at the time when they learned the news:

(31) *Cuando los padres se enteraron, montaron en furia, la golpearon sin piedad y no le permitieron explicar los reales hechos.* [SPANISH]
'When the parents learned about it, they became furious, they beat her remorselessly and didn't let her explain the real facts.'
Decididamente, la cosa ***tenía*** *que haber sucedido tal como la gente*
decidedly the thing have.IMPF COMP have.INF happened such as the people

decía
say.IMPF
'Definitely, the whole thing had to have happened as people were saying.'
La culpa de todo ***debía*** *tenerla* *ella.*
the fault of all must.IMPF have.INF.3PS.CL she
'Everything must have been her fault.'
[Dimas Aranda, S. *Tiempo de agonía* <http://www.biblioteca.org.ar/libros/88623.pdf>]

In English, parallel examples of simultaneity with an implicit past attitude may involve 'modals for the present', as in (32a), or 'modals for the past', as in (32b):[11]

(32) a. The parents thought their son was insane because he wanted to make a living selling and manufacturing Aeolian harps, beautiful stringed instruments that play eerie music when the wind blows through them. Why didn't he want to go to business school and take over Dad's business? Why didn't he want to be a doctor or a lawyer? **He must be ill**, mad or very bad! (internet) (ex. from Boogaart 2007)
b. I opened the fridge because there **might have been** some ice cream in there.
(ex. adapted from von Fintel & Gillies 2008)

Such examples have been argued to show that epistemic readings may have a past temporal perspective or that epistemic modals may scope under a past temporal operator. The debate as to how to represent this past temporal operator and which morphological ingredients express it is somewhat inconclusive (see Portner 2009, Section 4.2.2). Whatever the right analysis for these cases turns out to be, it seems clear that an appropriate context for the English examples above, no less than for the parallel Romance examples involving modals bearing *imparfait* morphology, requires licensing by an implicit past attitude. If this is the case, the label "past temporal perspective" is misleading as applied to them: the temporal perspective is actually simultaneous ('present'), but it is simultaneous to a past attitude, as it is the case in overt sequence of tense contexts.

As for Romance, sequence of tense and free indirect speech contexts provide arguments in favor of the semantic account of the interaction between epistemic modals and past tense. This interaction is constrained by the requirement of simultaneity of the time of modal evaluation with the time of the attitude. Temporal morphology on the modal determines temporal perspective in terms of a contrast between simultaneity with the time of utterance (non-past morphology, deictic present interpretations) or simultaneity with a past attitude (*imparfait*-like past morphology, anaphoric zero-tense interpretations). If one assumes, as it seems reasonable, that the contrast between deictic and zero tenses is necessarily hosted by a tense projection, the syntactic claim that epistemic modals necessarily scope above this projection is falsified by examples such as (29) above.

2.3.2 Past temporal orientation and overt "tense raising"

As discussed in the previous section, epistemic modals may also exhibit past morphology in cases in which the interpretation strongly suggests that we are not dealing with a past temporal perspective, but with past temporal orientation. The following examples illustrate epistemic readings with an *imparfait* which is not licensed by a past attitude (33a), with a perfect (33b), and with a past perfect (33c) in French:

(33) a. *Marie devait* *détester Pierre depuis longtemps*. [FRENCH]
Marie must.IMPF hate Pierre since long time
i. 'Marie must have hated Pierre for a long time.'

ii. 'It is inferable from what I know now that Mary had hated Pierre for a long time.'

b. *Il a dû pleuvoir toute la nuit.* [FRENCH]
it has must.PART rain all the night.
i. 'It must have rained the whole night.'
ii. 'It is inferable from what I know now that it rained the whole night.'

c. *Il avait dû s'enfuir avant l'arrivée de la police.* [FRENCH]
he had must.PART REFL-flee before the arrival of the police
i. 'He must have fled before the police arrived.'
ii. 'It is inferable from what I know now that he had fled before the police arrived.'

As already mentioned, there has been a widespread consensus that these configurations involve scope reversal between the modal and tense-aspect morphology (Stowell 2004, Borgonovo & Cummins 2007, Demirdache & Uribe-Etxebarria 2006, 2008, Hacquard 2006): tense-aspect morphology is realized on the modal, but it seems to specify the temporal location of the described eventuality, i.e. temporal orientation. The crucial empirical argument for scope reversal is the choice of past morphology appearing on the modal, which in most cases exactly matches the choice that would be mandatory for the main verb of the corresponding non-modalized sentence (Tasmowski 1980). Thus, the choice of an *imparfait* in (33a) and of a perfect in (33b) relates to the fact that these past tenses are the most natural or only choice in the non-modalized sentences (34a) and (34b):

(34) a. *Marie détestait Pierre depuis longtemps.* [FRENCH]
Marie hate.IMPF Pierre since long time
'Marie had hated Pierre for a long time.'

b. *Il a plu toute la nuit.* [FRENCH]
it has rain.PART all the night
'It rained the whole night.'

However, if one assumes that examples like (33a-b) have a present temporal perspective and a past temporal orientation, the prediction is that such sentences are equivalent to sequences expressing present temporal perspective by present tense on the modal and past temporal orientation by a perfect infinitive, which are also possible in the language.

(35) a. *??Marie doit avoir détesté Pierre depuis longtemps.* [FRENCH]
Marie must.PRES have hate.PART Pierre since long time

b. *Il doit avoir plu toute la nuit.* [FRENCH]
it must.PRES have rain.PART all the night
'It must have rained all night.'

This prediction is not borne out in a number of cases. Thus, the acceptability of (33a) contrasts with the dubious character of (35a). Moreover, recent research by Martin (2011) and Mari (2015) suggests that there are also subtle contrasts between the epistemic readings in the linearizations PERFECT-MODAL-INFINITIVE, as in (33b), and MODAL-PERFECT-INFINITIVE, as in (35b). Whether the anteriority relation determining a past temporal orientation is realized as past or perfect morphology on the modal or as perfect morphology on its infinitival complement is not entirely without semantic consequences. A mechanism of 'overt perfect raising', by which perfect morphology affecting temporal orientation appears on the modal, is attested sporadically in some languages, as for instance Dutch (Boogaart 2007) and some Norwegian dialects (Eide 2005), and is rather systematic in Modern French. Variation across Romance languages on this point (Mari 2015) points to the existence of a process of syntactic change.

To summarize, past temporal morphology on an epistemic modal appears to have two distinct sources:

(i) it may be a reflection of the time of the attitude, giving rise to a contrast between present tense in run-of-the mill matrix contexts and anaphoric past tenses (zero tenses) in past embedding contexts and in free indirect speech.

(ii) it may be a reflection of a past temporal orientation, which could account for the full inventory of past tenses in run-of-the-mill matrix contexts.

Since present tense and zero tense are distinct temporal operators, (i) shows that epistemic modals may indeed have scope under temporal operators. As to (ii), the mismatch between morpho-syntactic and semantic scope it lays bare poses a number of issues for compositionality.

3. Open issues

Despite the existence of commonly admitted generalizations regarding the interaction of modal verbs with aspectual and tense operators, and the considerable effort that has been devoted to developing compositional accounts for these generalizations, there remains a number of open issues in this area. In fact, Portner (2009: 230) does not seem to be overly pessimistic when he states that "it is obvious that we don't yet have a good understanding of what happens when a modal is combined with temporal operators". In this section, we explore two problem cases: (i) the exact nature of the epistemic-counterfactual ambiguity, and (ii) the derivation of the actuality entailment. In both cases, recent research on languages in which modals exhibit a richer and more transparent tense-aspect morphology than is the case in English has uncovered new facts that cast some doubt on existing analyses.

3.1 The epistemic-counterfactual ambiguity

The epistemic-counterfactual ambiguity can be illustrated by the two possible construals of (36) in English, a construal of epistemic uncertainty compatible with the continuation in (i) and a counterfactual construal which strongly suggests that the speaker believes the prejacent to be false (ii):

(36) Mary might have won the race.
(i) I wonder if she actually did.
(ii) But she didn't.

In English, the necessary ingredients for this ambiguity to arise are (i) perfect morphology in the complement of the modal and (ii) past/subjunctive morphology on the modal itself. Condoravdi (2002) attributes this ambiguity to a difference in the temporal configurations involved. In the epistemic construal, the temporal perspective is present and the temporal orientation, as determined by perfect morphology, is past. The sentence conveys that Mary's having won the race (in the past) is compatible with the evidence available to the speaker (at the utterance time). In the counterfactual construal, the temporal perspective is past, and the temporal orientation is future. The interpretation is that at some point in the past, the actual world was such that it could evolve into a world where Mary won the race. The difference between these two temporal configurations is made more perspicuous by the distribution of the presuppositional adverbs *already* (favoring the epistemic construal) and *still* (favoring the counterfactual construal). Crucially, Condoravdi hypothesizes that the difference in temporal configuration correlates with a difference in the formal type of modal base that provides the background for interpretation. Along the lines discussed in section 1.1. above, the temporal configuration associated to the counterfactual construal, which is tantamount to a 'future in the

past', is compatible with a metaphysical (or circumstantial) modal base. The temporal configuration associated to the epistemic construal, determining a past temporal orientation, and therefore decidedness of the issue at the time of modal evaluation, requires ignorance alternatives as a background for interpretation, and therefore an epistemic modal base.

The existence of this ambiguity has thus provided some of the original motivation for the link between temporal orientation and formal type of modal base summarized in section 1.1 above. Condoravdi (2002) accounts for the 'future in the past' configuration attributed to the counterfactual construal by assuming a covert raising of the perfect operator which is overtly realized in the complement of the modal. By scoping above the modal, the anteriority relation conveyed by the perfect affects temporal perspective and not temporal orientation.

The counterfactuality ingredient, i.e. the inference that the speaker believes the prejacent[12] to be false, is analyzed by Condoravdi as an implicature arising from the choice of a past temporal perspective. In the branching-futures model underlying metaphysical or "objective" modality (cf. e.g. Thomason 1984, Steedman 1997), possibilities decrease with the flow of time/of events; consequently, a past temporal perspective widens the domain of quantification, by accessing a superset of the set of worlds that are accessible from the present. The most obvious reason for domain widening would be to recover a world history that the speaker knows to have been discarded by the course of events. Hence the implicature that no worlds verifying the prejacent are accessible from the time of utterance.

Condoravdi's analysis is embedded in what is certainly the most fully worked-out formal treatment of modal-temporal interactions to this date (see also Kaufmann, Condoravdi & Harizanov 2007). However, there are a number of empirical problems with this account, mostly revealed by cross-linguistic studies, and the nature of the ambiguity itself is far from clear.

First, the question as to why the covert raising of perfect morphology - which is hypothesized to trigger the counterfactual construal - should only be possible in the case of subjunctive/past modals in English is not at all addressed in the analysis.[13] In fact, the counterfactual construal depends at least as much on the special morphology on the modal as on the presence of perfect morphology.

Second, as shown by languages which can freely express past temporal perspective by past tense inflection on the modal, it is not true that a past perspective associated with future orientation is enough for counterfactuality to arise. *Pace* Hacquard (2006: 77) a modal in the *imparfait* in French does not convey counterfactuality. Counterfactuality means at the very least compatibility with contexts establishing the falsity of the prejacent. This is a property that past/subjunctive modals embedding the perfect auxiliary *have* in English have, as shown in (37a-b), but modals in the *imparfait* in Romance lack, as shown in (38a-b):

(37) a. The patient died, though he could have survived.
b. She could have won earlier than she did.

(38) a. *#Le patient est mort, mais il pouvait survivre.* [FRENCH]
the patient died but he can.IMPF survive
b. *#Elle pouvait gagner plus tôt qu' elle ne l'a fait.* [FRENCH]
she can.IMPF win more early than she not CL-has done

In fact, the preferred expression for the counterfactual construal in French has the same ingredients as in English: perfect morphology and subjunctive/counterfactual morphology, which in the case of French tend to appear both on the modal. Thus, (37a-b) is more adequately rendered as in (39a-b):

(39) a. *Le patient est mort, mais il aurait pu survivre.* [FRENCH]
the patient died but he have.CF can.PART survive

b. *Elle aurait pu gagner plus tôt qu' elle ne l'a fait.* [FRENCH]
she have.CF can.PART win more early than she not CL-has done.

Third, Condoravdi attributes the possibility of covert perfect raising in English to the fact that, in this language, the syntax fixes the linear order MODAL-PERFECT. Languages whose syntax also allows the surface order PERFECT-MODAL are predicted to exhibit the two scopal options overtly, with the order MODAL-PERFECT for the epistemic and the order PERFECT-MODAL for the counterfactual construal. However, careful examination of French and Spanish, which do allow both orders, does not confirm this prediction. The option of choice for conveying counterfactuality in these languages involves counterfactual morphology above the modal.[14] Now, one of the possible orders in each language (which happens to be PERFECT-MODAL in French and MODAL-PERFECT in Spanish) is both compatible with the construal of epistemic uncertainty and with the counterfactual construal (Laca 2012), as shown in (40) for French:

(40) *Marie aurait pu gagner la course.* [FRENCH]
Marie have.CF can.PART win the race
'Marie might have won the race.'
i. *C'est une possibilité à ne pas exclure.*
'This possibility shouldn't be discarded.'
ii. *Mais elle a perdu.*
'But she lost.'

The question arises here as to the status of the difference between epistemic and counterfactual construals. It would be surprising for a genuine ambiguity to be reproduced in languages which have the syntactic patterns required to resolve it. Both French and Spanish, unlike English, have the possibility of having perfect morphology above the modal (associated to the counterfactual construal in Condoravdi's analysis) or below the modal (associated to the epistemic construal in Condoravdi's analysis). But both exhibit the epistemic-counterfactual 'ambiguity' for at least one of those linearizations. Moreover, the same 'ambiguity' resurfaces in other morpho-syntactic guises, for instance in Spanish in sequences in which a modal in the perfective past embeds a perfect infinitive (for the full patterns, see Borgonovo & Cummins 2007, Laca 2012):

(41) *Maria pudo haber ganado la carrera.* [SPANISH]
Maria can.PAST.PFV have won the race
'Maria might have won the race.'

In Condoravdi's account, the epistemic construal is assimilated to the epistemic uncertainty of the speaker and interpreted against a background of ignorance alternatives as to settled facts. By contrast, the counterfactual construal is interpreted against a background of (future) metaphysical alternatives fanning out from a point in the past, but which are decided from the point of view of the present. However, several authors (see for instance Abusch 2008, Portner 2009: 225) have pointed to the difficulty of deciding whether the modal base providing the background for interpretation is an epistemic or a metaphysical one, particularly in examples like the following, which involve states:

(42) a. I looked in there because the keys might have been in the drawer. But they were *not.*
b. We bought a ranch which might well have contained a significant oil reserve. But it didn't.

As shown by the continuations, these examples are compatible with a counterfactual construal. The temporal perspective is simultaneous to an implicit past attitude (that of the speaker at the time of the search for the keys, or at the time of the buying of the ranch). But the alternatives captured by backshifting the temporal perspective are not metaphysical alternatives: they do not involve alternative world histories which are identical up to a time in the past, with changes in the actual location of the keys or changing properties for the oil field. Rather, they involve changes in the information available to the relevant epistemic agent at a previous time. Examples of this kind are both epistemic, in as far as their modal background is the partial information or evidence available to an epistemic agent, and counterfactual, because what was a live epistemic possibility at the time of modal evaluation has been discarded at utterance time.

The foregoing discussion should have convinced the reader of an important *caveat*. If the epistemic-counterfactual ambiguity is a genuine one, it cannot safely be tested by appealing to the epistemic state of the speaker at the time of utterance, i.e. by the tags of the type "for all I know", which it has become common practice to use for distinguishing both readings.

3.2 The actuality entailment

As mentioned in section 2.1, the label "actuality entailment" (see also Chapter 56 *Actuality entailments*) applies to the implicative-like behavior[15] of modal verbs in some contexts that seem to entail the truth of the prejacent proposition, as suggested by the apparent contradictoriness of continuations which negate it. The following French examples illustrate this behavior:

(43) a. *Jane put traverser le lac à la nage, #mais elle ne le fit pas.*
Jane can.PAST.PFV cross the lake by swim but she it do.PAST.PFV not
'Jane could (was able to) swim across the lake, but she didn't do it.'
b. *Jane pouvait traverser le lac à la nage, mais elle ne le fit pas.*
Jane can.PAST.IMPF cross the lake by swim but she it do.PAST.PFV not
'Jane could (was able to) swim across the lake, but she didn't do it.'

As shown by the contrast between (43a) and (43b), there is a correlation between the emergence of the actuality entailment and the presence of perfective aspectual morphology on the modal. This correlation obtains in a number of languages with an overt perfective/imperfective distinction (Greek, Hindi, Italian, Catalan, Bulgarian). In English, which lacks this overt distinction, an implication of actuality arises for the modal expression *be able to* in some past tense contexts - particularly in those with adverbials specifying a relatively short reference time as (44a), but not in the present or in the future (44b-c) (Piñón 2003):

(44) a. Yesterday afternoon, Rebecca was able to swim across Lake Balaton.
b. Rebecca is able to swim across Lake Balaton.
c. Tomorrow, Rebecca will be able to swim across Lake Balaton.

Although the actuality entailment has been mainly discussed for possibility modals, probably because the apparent entailment pattern $\Diamond p \rightarrow p$ is problematic, it has been shown to arise also in the case of necessity modals (Hacquard 2006):[16]

(45) *Jane a dû entrer par la fenêtre, car elle avait perdu ses clés*, [FRENCH]
Jane has must.PART enter by the window since she had lost her keys
 # mais elle ne l'a pas fait.
but she it has not done

'Jane had to go inside through the window, because she had lost her keys, but she didn't'

Most existing analyses of the actuality entailment rely on the aspectual correlation and attribute its emergence to perfective aspect scoping above the modal verb. The lack of actuality entailment with imperfective morphology is explained by the modal-like semantic contribution of imperfective morphology, which introduces a second layer of modality above the modal verb. Analyses differ in the semantics they attribute to the modal itself, and therefore in the mechanisms invoked for deriving the actuality entailment.

Hacquard (2006, 2009) maintains that modal verbs giving rise to the actuality entailment make the same semantic contribution as in other contexts: they are quantifiers over possible worlds. The analysis she develops builds on the idea that aspect not only contributes existential quantification over an event description whose temporal trace is ordered with regard to a time variable (the reference time), but also introduces its own world variable, together with the restriction that the event belongs to that world. Thus, perfective aspect is defined as in (46):

(46) $[|\text{PERFECTIVE}|]^{w,B \leq, c} = \lambda P_{<\varepsilon,t>}.\ \lambda t_{<i>}\ \exists e\ [\underline{e \text{ in } w}\ \&\ \tau(e) \subseteq t\ \&\ P(e)]$

This is to say, perfective aspect is function which takes a property of events P and returns a set of intervals such that they include the temporal trace of a P-event taking place in a given world. The principles accounting for the binding of free variables ensure that the world variable in the underlined conjunct is identified with the actual world variable in matrix sentences (provided that there are no higher modal operators).

Modals giving rise to the actuality entailment have the type of modifiers of event descriptions (<<ε,t> <ε,t>>). The result of composing a possibility modal with the event description denoted by the VP *Jane-run* is given in (47a):

(47) a. λe. ∃w' compatible with circumstances in w: run(e,j,w')

The modalized event description denotes a set of events such that there is at least a world compatible with the circumstances in the actual world such that Jane runs in this world.

The result of applying the perfective operator to this modalized event description is given in (47b):

b. $\lambda t_{<i>}.\exists e\ [\underline{e \text{ in } w}\ \&\ \tau(e) \subseteq t\ \&\ \exists w'$ compatible with circumstances in w: run(e,j,w')]

If the time of which the temporal property in (47b) is predicated is further restricted as past (by a past tense operator), we obtain truth conditions that can be paraphrased as in (48):

(48) *There is an event in the actual world located in a past interval and there is a world compatible with the circumstances in the actual world where that event is a run by Jane*

In order to derive the actuality entailment, it is necessary that the event whose existence is asserted for a past interval in the actual world should be of the same type as the "possible" event, i.e. a running by Jane. Hacquard formulates a pragmatic principle, *Preservation of Event Descriptions Across Worlds*, which ensures precisely this:

(49) *Preservation of Event Descriptions Across Worlds*: for all worlds w1, w2, if e occurs in w1 and w2 and e is a P-event in w1, then *ceteris paribus*, e is a P-event in w2

According to Hacquard, this principle amounts to a pragmatic default. Although the principle has been criticized on the grounds that it does not always accomplish what it is meant to (see Portner 2009, Section 4.4.1), it is not entirely devoid of motivation. Individual events - which are actually newcomers in ontologies for model-theoretic semantics - are more fundamentally intensional than individual entities. Whereas natural language has rigid designators (proper names for individuals or for kinds of things, see Kripke 1980) for entities, it lacks this sort of expression in the verbal domain. Preservation of event descriptions across worlds simply indicates that the properties of an individual event are essential properties, i.e. such properties that cannot vary without making it a different individual. Whereas it seems unquestionable that individual events get their identities by description (see among others Landman 2000, Lecture 2), it is debatable whether the same holds of individual entities.

Hacquard's account offers a neat compositional derivation for the actuality entailment, with a standard treatment for perfective aspect and a uniform treatment for modal verbs. This treatment makes it possible to represent the difference between possibility and necessity modals in sentences exhibiting the actuality entailment as a difference in quantification. A necessity modal expresses that in all the (best) worlds compatible with the circumstances in the current world, the event is a P-event, whereas a possibility modal gives rise to the scalar implicature that there are worlds compatible with the circumstances in the actual world in which the event is not a P-event. There are, however, certain salient implications of sentences exhibiting the actuality entailment whose relationship with the quantificational force of the modals is not sufficiently understood. Most importantly, these sentences seem to require an intentional agent (not necessarily coinciding with the sentential subject) whose intentions are fulfilled (in the case of the possibility modals) or thwarted (in the case of the necessity modal). As shown by the possible continuations in (50a) and (50b), the possibility modal suggests that this intentional agent prefers p to $\neg p$, whereas the necessity semi-modal suggests that $\neg p$ is preferred to p.

(50) a. Eventually, Jane had to pay her taxes, though she didn't want to/#as she intended.'
b. Eventually, Jane was able to pay her taxes, #though she didn't want to/as she intended.

These inferences do not seem easily cancellable, nor are they straightforwardly derived from the semantic analysis proposed by Hacquard. The content of these inferences - which have to do with the ways in which circumstances affect the actions available to a volitional agent - suggests that the modality involved corresponds to the type of volitional modality identified by Portner (2009: 135). Portner proposes a finer-grained articulation in the traditional domain of root modals, distinguishing priority modals, whose background for interpretation involves preference structures as ordering sources, from volitional modality, which subsumes the meanings of ability and opportunity and whose ordering sources are based on the plans and desires of an individual. Hacquard's analysis of root modals, which treats them as modifiers of eventuality descriptions, might only be adequate for this type of root modality, and not extend to priority modals.[17]

At least two issues related to the actuality entailment are in need of further research: the relation between modalized sentences carrying the actuality entailment and implicative verbs and the exact role of aspect.

As for the first issue, the original analysis of the actuality entailment sketched by Bhatt (1999) stresses the parallels between modals exhibiting the actuality entailment and eventive implicative verbs such as *manage*. In some languages, such as Modern Greek and Georgian (Giannakidou & Staraki 2013), modals exhibiting the actuality entailment enter the same syntactic patterns as implicative verbs, as shown by the coordinating construction in (51a, b), which entails the truth of the complement clause.

(51) a. *I Maria borese ke eftiakse to aftokinito*. [GREEK]
the Maria can.PFV.PAST and fix.PFV.PAST the car
'Mary could, and did, fix the car'.
b. *O Janis katafere ke ipje 10 bires*. [GREEK]
the John manage.PFV.PAST and drink.PFV.PAST ten beers
'John managed to drink ten beers'.

This contrasts with the complementizer constructions introduced by "subjunctive" *na,* which are also possible both for implicative and for modal verbs, but do not necessarily entail the truth of the complement clause of the modal verbs.

Thus, there are clear semantic and syntactic parallels between modal verbs exhibiting the actuality entailment and implicative verbs. The problem is that assimilating both categories will introduce an unwarranted lexical ambiguity for modals unless a unified analysis is developed (see Giannakidou & Staraki 2013 for some suggestions in this sense). Since the standard unified treatment for modals has been achieved by analyzing them as quantifiers over possible worlds, unification would require extending the idea of quantification over alternatives to the semantics of implicative verbs.

As for the role of aspect, the lack of the actuality entailment with imperfective morphology is attributed both by Bhatt (1999) and Hacquard (2006, 2009) to the presence of a modal-aspectual Generic operator expressed by imperfective morphology. Indeed, the morphological facts from Hindi suggest that it is the generic variant of imperfective aspect that is relevant for the cancellation of the actuality entailment: Hindi has a specific imperfective marker for generic/habitual statements, *-taa*, and it is this marker, and not the progressive imperfective marker,[18] that cancels the actuality entailment in the ability attribution constructions:

(52) *Yusuf havaii-iahaaz ur aa sak-taa hai/ thaa* [HINDI]
Yusuf air-ship fly can.IMPF be.PRS/be.PST
'Yusuf is /was able to fly planes. '

As is well-known, dispositional generic sentences such as (50a-b) do not entail the corresponding episodic sentences describing particular instantiations of the disposition (cf. Krifka et al. 1995):

(53) a. This machine crushes oranges.
b. Sally handles the mail from Antarctica.

This effect is standardly attributed to the semantic properties of the Generic operator. Hacquard (2009) provides a formal version of imperfective aspect as an expression of genericity/habituality, which introduces a further layer of modality above the modal itself. Since imperfective aspect provides quantification not only over events, but also over worlds in a modal base restricted by an ordering source, and it is not required that this restriction be realistic (that the actual world belong to the domain of quantification), no actuality entailment is derived in such cases. Notice that the lack of actuality entailments in future sentences (see (44c) above) could be explained by an analogous mechanism, if the future is understood as a modal operator involving universal quantification over a restricted set of worlds.

Bhatt's and Hacquard's analyses share the commitment to the generalization that the actuality entailment is an effect of perfective aspect above the modal, whereas cancellation of the actuality entailment is linked to the modal nature of imperfective aspect. This generalization has come under closer scrutiny in recent research, which tends to indicate that the correlation

is less clear than assumed (Mari & Martin 2007, Homer 2010, Giannakidou & Staraki 2013). A number of facts suggest that it is not perfective aspect *per s*e that is responsible for the actuality entailment. The entailment also arises with progressive aspect (cf. footnote 16), with adverbials specifying a short time frame (cf. Piñón's example (44a) above), and with event quantification, as shown in (54a-b):

(54) a. Rebecca was able to swim across Lake Balaton twice in her life.
b. Every time she was questioned, she was able to supply a satisfactory answer.

An entirely novel view on the basis for the actuality entailment or lack thereof has recently been proposed by Matthewson (2011), who links the lack of actuality entailments to the future temporal orientation of modals. Her hypothesis is based on the facts of Gitksan (Tsimshianic, British Columbia). As mentioned in section 1.2 above, this language obligatorily marks forward-shifting (prospective aspect, future time reference) by means of the marker *dim*. This marker is obligatorily embedded under circumstantial modals, which consistently lack the actuality entailment in this language. By contrast, Blackfoot (Algonquian) has an optional prospective marker whose presence correlates with the lack of an actuality entailment.[19] Matthewson further assumes that the future temporal orientation of modals is always dependent on a prospective aspect marker, which in some languages is both covert and optional. Under this assumption, accounting for the actuality entailment is tantamount to explaining why the covert prospective marker is absent when the modal bears perfective aspect or in the other contexts mentioned in the preceding paragraph.

This concludes our survey of temporal-modal interactions. Other important aspects relevant to this topic, which have not been adequately covered here, include tenses and aspects that have been shown to require a modal treatment and/or give rise to modal interpretations in some of their uses, such as future tense (cf. Chapter 40 *Reference to future events: Sea battles*), irrealis tenses (cf. Iatridou 2000, as well as Chapter 53 *Counterfactuals*), imperfective and progressive aspect (cf. Chapter 35 *Imperfectivity,* Ippolito 2004) or evidential perfects (Izvorski 1997), as well as the various temporal configurations of other modal structures (in particular imperatives or conditionals, cf. Copley 2008, Kaufmann 2012, Ippolito 2013 among many others). We hope however to have shown that progress has been made in understanding the interaction between modality and time and to have emphasized the way in which cross-linguistic work motivates and regulates theoretical developments.

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o SEE ALSO: Chapter 35 *Imperfectivity*, Chapter 37 *Lexical aspect,* Chapter 40 *Reference to future events: Sea battles*, Chapter 45 *The interpretation of tense,* Chapter 47 *Sequence of tense*, Chapter 53 *Counterfactuals*, Chapter 56 *Actuality entailments*, Chapter 57 *Epistemic Modality,* Chapter 59 *Graded modality*

o Biographical note

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Endnotes

[1] In fact, the relationship between a modal base understood as a set of propositions or as a set of worlds mirrors the relationship between the *common ground* (set of propositions) and the *context set* (set of worlds) in the Stalnakerian approach to context.

[2] Formally, they constitute unions of sets of equivalence classes of world histories relative to a time t. Members of this union not belonging to the same equivalence class may differ in the truth value assigned to a proposition, even when its truth value depends on facts not later than t.

[3] Interpreting a modal operator against the background of a non-diverse modal base can be shown to yield a number of anomalies: equivalence between modalized and non-modalized assertions (Condoravdi 2002), vacuousness of the ordering among worlds asserted by bouletic operators (Heim 1992) or stipulated by the ordering source (Werner 2003), vacuous truth of conditionals or equivalence between conditionals and their consequents (Kaufmann 2005). The intuition is that the diversity condition reflects a general interpretive strategy for avoiding such anomalies.

[4] For discussion of the interaction between circumstantial modality and the diversity condition, see Thomas (2014).

[5] Matthewson (2014) reports on a survey by van der Auwera and Amman (2011) which suggests that lexical determination of the type of modality is more widespread among the languages of the world than the context-dependency which is typical for modal verbs in the best described modern European languages.

[6] The strong stative-eventive contrast we find in English is arguably a consequence of a morphological aspectual system which precludes ongoing (state-like) interpretations for eventive predicats in the absence of overt progressive operators.

[7] This sort of motivation has been adduced for the shifting towards the past of non-progressive eventives in tenseless or FUTURE-NON FUTURE languages by e.g. Smith (2008).

[8] The term "root modality" is introduced by Hofmann (1966) to refer to non-epistemic interpretations of modals, such as deontic and dynamic interpretations.

[9] These examples contain perfective past forms. In Modern Colloquial French, the *passé composé* (built with the auxiliary *avoir/être* in the present tense plus a past participle, as in examples (17a-b) and (18), has for all practical purposes replaced the older *passé simple* (examples (19a-b) below) as a perfective past.

[10] The interpretation of some English modal auxiliairies as for instance *might* (originally a morphologically past form of *may*), in (i)) and *should* (past form of *shall*) in (ii), has also been claimed to show that past morphology does not determine a past temporal perspective in the case of epistemic modals:

(i) John might go home today.
'It may be that John will go home today.'
(ii) Susan should be at the station.
'It's likely that Susan is (or will be) at the station.'

In both cases, the (arguably present) past tense morphology does not receive a true past interpretation – the epistemic modal has unambiguously a present temporal perspective.

[11] The labels "modals for the present" for modals embedding bare infinitives and "modals for the past" for modals embedding bare infinitives bearing perfect morphology are taken from Condoravdi (2002).

[12] We follow von Fintel (2006) in referring to the proposition expressed in the complement of the modal verb as the prejacent proposition.

[13] See Stowell (2004) for the outline of an explanation in which English subjunctive/past modals are past polarity items requiring to be licensed by a higher past tense, which could be provided by covert raising of the perfect (and is overtly provided by a matrix past tense in embedded contexts).

[14] There is reason to assume that modals bearing counterfactual morphology in Romance are near equivalents to English subjunctive/past modals (von Fintel & Iatridou 2008), and that counterfactual morphology acts as a domain-widener, indicating that worlds are being accessed which do not belong to the common ground. In the absence of perfect morphology, counterfactual morphology simply indicates weak possibility or weak necessity, comparable to what conveyed by *might/could* and *ought*/*should* in English.

[15] Implicative verbs, of which *manage* is a prototypical example, are characterized by the fact that their assertion entails the truth of their complement clause, whereas their negation entails its falsity (Karttunen 1971).

[16] Giannakidou & Staraki (2013), on the basis Modern Greek data, contend that the actuality entailment only arises with possibility modals and is linked to ability as a causal force.

[17] Hacquard (2006) explicitly assumes that deontic modals give rise to the actuality entailment. However, her example (17b) above, repeated here for convenience, poses a number of problems.

(i) *Lydia a pu aller chez sa tante (selon les orders de son père),* [FRENCH]
Lydia has can.PART go to her aunt (according the orders of her father)
#mais n'y est pas allée.
but is not gone
'Lydia could go to her aunt (according to her father's orders), but she didn't go.'

Although it contains an overt expression designed to capture a deontic ordering source ('according to her father's orders'), Lydia's wishes and plans are crucial for the actuality interpretation. The lack of clear criteria for distinguishing subtypes of modality makes itself acutely felt in cases like this one.

[18] In fact, progressive aspect, when it is at all compatible with modal verbs as in the Spanish example (i), carries the actuality entailment.

(i) *A las localidades aisladas solo estamos pudiendo llegar por helicóptero*. [SPANISH]
to the settlements isolated only be.PRES.1.PL can.GER arrive.INF by helicopter
'We are only being able to reach isolated settlements by helicopter.'

[19] The Blackfoot examples, however, suggest that in this case the prospective marker scopes above the modal. If this were the case, they would simply illustrate the lack of actuality entailments with a future temporal perspective exemplified under (44c).